

NEUDÖRFER'S METHOD OF AMPUTATING EXTREMITIES, WITH A REPORT OF TWO THIGH AMPUTATIONS.¹

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THE method of amputating, which I wish to bring to notice in this paper, is one which Professor Neudörfer,² of Vienna, described. My attention was drawn to the method during the winter of 1892. I had the opportunity to practise it experimentally on the cadaver, while practically demonstrating operative surgery before the class. The practical points observed in these experimental studies of the method on the cadaver determined me to execute it on the living subject as soon as an opportunity should present itself. This opportunity presented itself during the last winter, the results of which will be detailed further on in my remarks.

Neudörfer applies the principles of the technique involved in this method both to amputations in continuity and in continuity. I shall deal in this paper only with amputations in continuity. The amputations in continuity are divided,—

(1) Through regions where there is only a single bone to be divided, as in the thigh and in the upper arm.

(2) Through regions where there are two bones to be divided, as in the forearm and in the leg.

Technique where One Bone is Divided.—The first step in the operation is to determine the point at which the bone is to be

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The sketches of figures were executed by my friend, Dr. Louis Crucius, from photographs taken during operations.

² Wiener medicinische Wochenschrift, Nos. 2 to 5 inclusive, January, 1891.

divided. For example, we will assume that we wish to amputate the thigh at the junction of the lower with the middle third. If the bloodless operation of Esmarch is employed, the limb is first rendered bloodless by the application of the bandage and constrictor. If the bloodless method is not employed, the vessels are controlled either by a constrictor or by the fingers of an assistant. Having determined the point where we wish to divide the bone, an incision is made with a sharp-pointed, strong resection knife, extending downward, in the long axis of the limb, through the soft parts and periosteum. The incision should be made on the lateral or anterior aspect of the limb, where the bone is more

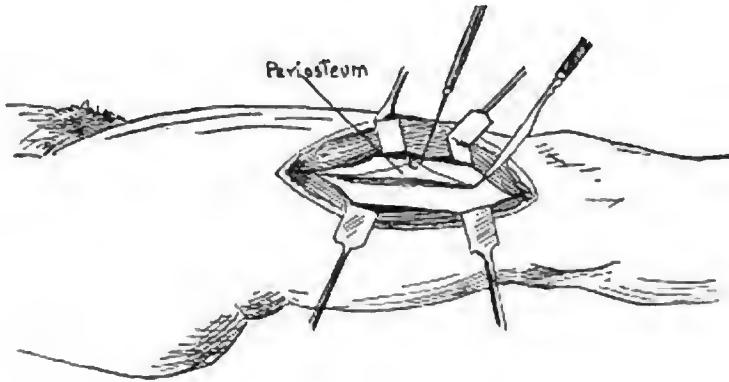


FIG. 1.—FIRST STEP.—Incision through soft parts and periosteum. Soft parts held apart by retractors. Periosteum incised and elevated from bone.

superficial, and where the large vessels and nerves are avoided. In the thigh, the incision should be made about twelve centimetres in length, or about four and a half inches. With large-sized retractors the soft parts are held apart. The periosteum is now thoroughly loosened from the bone in the line of the incision with a raspatory. With a chisel the bone is cut through at the upper angle of the wound (line for division), as in an osteotomy. The lower fragment is luxated through the slit in the periosteum, and the membrane (periosteum) carefully stripped from the bone.

The soft parts are now divided at the site of the lower angle of the wound, in one plane transversely to the axis of the limb, with an amputating knife, scalpel, or even with a large pair of

scissors. The vessels are next secured by ligatures. Having secured the vessels, the periosteum is stitched together with a fine catgut, continuous, buried suture, both longitudinally and transversely, obliterating the cavity of the periosteum which was occupied by the bone. The muscles are now united by a continuous, buried, catgut suture, and, finally, the skin in the same manner.

In amputations of the upper arm, the incision is made on the outer aspect of the limb, and is to be about six centimetres, or two and a fourth to two and a half inches in length. The

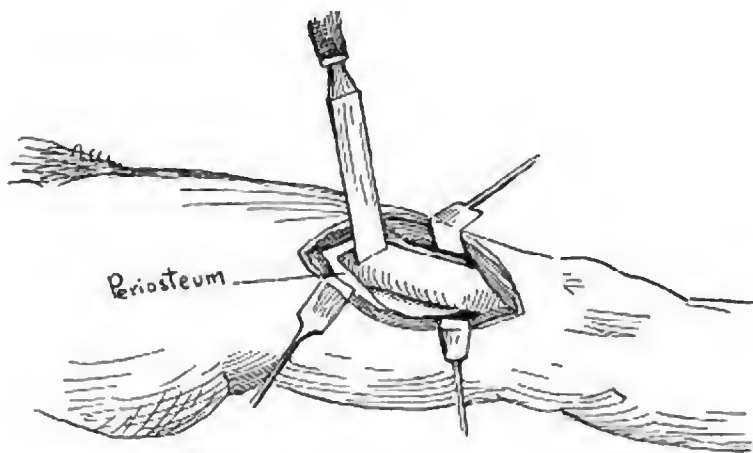


FIG. 2.—SECOND STEP.—Soft parts and periosteum retracted. Chisel in position for osteotomy in upper angle of the wound.

other steps in the operation are the same as described for amputations of the thigh.

Technique where Two Bones are to be Divided.—The same technique is carried out in amputations of the leg and forearm, with the exception that an osteotomy of two bones must first be made before the soft parts are cut through.

In the forearm the incision is made over the middle of the ulna and radius on the dorsal side, six centimetres in length. Here the bones are very superficial. In making the incisions the arm should be kept midway between pronation and supination.

For amputations of the leg the incision is made over the tibia, at the point selected, either on the inner or outer aspect of

the crest, and about nine centimetres in length. Neudörfer prefers the outer aspect. The tibia is first cut through with a chisel, then the fibula is divided either on the same plane or a little higher up. All the other steps are the same as already described, the only difference being that in amputation of the leg and forearm we have two periosteal cavities to obliterate and two skin wounds, respectively, over ulna and radius, or over tibia and fibula.

The arguments brought by Neudörfer against the older methods of amputation are,—

- (1) The irregular division of the soft parts.
- (2) The bone is usually divided higher than necessary.
- (3) Troublesome cicatrices often result.



FIG. 3.—THIRD STEP.—Osteotomy of bone at upper angle of wound. Circular division of soft parts at lower angle of wound.

- (4) The saw does unnecessary injury to the bone.
- (5) Periosteal flaps, being deprived of nutrition, do not re-produce bone.

- (6) Conical stumps may be formed.
- (7) A special set of cumbersome instruments is required.

The advantages of the method suggested by Neudörfer are :

- (1) The soft parts remain in their normal relation to each other and cannot retract.

- (2) Not being able to retract, a soft cushion is provided for the bone.

- (3) The vessels may be controlled by the thumb and finger in the flap; the exact union of the tissues renders secondary hæmorrhage nearly impossible.

- (4) No troublesome cicatrices result.
 - (5) The periosteum retains all its nutritive and osteogenetic properties.
 - (6) Conical stumps are never produced.
 - (7) Skilled assistants are not necessary.
 - (8) Few special instruments are required.
 - (9) Drainage is unnecessary.
 - (10) This is the only real subperiosteal amputation.
- Objections that may be made to the method, are as follows :
- (1) It is new, has no statistics, and lacks the support of prominent men.
 - (2) In amputations of extremities containing two bones the

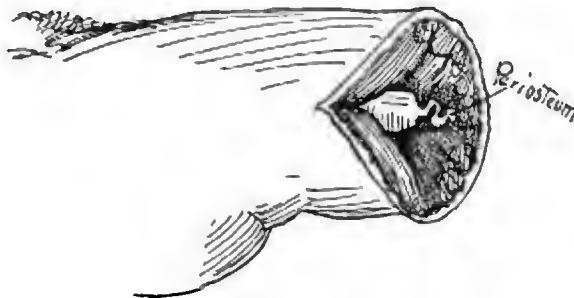


FIG. 4.—Periosteum, sutured muscles, and skin before coaptation by buried catgut suture.

operation seems to be more complicated than it really is ; and it certainly requires somewhat more time than the usual methods.

- (3) The method must first be practised on the cadaver.
- (4) Thickened periosteum is easily removed, but normal periosteum is elevated with considerable difficulty. There are no disadvantages from the side of the patient.

Experimental Studies of the Method on the Cadaver.—Having familiarized myself with the technique, I performed the amputations on the cadaver, so as to satisfy myself as to the possibility of the method, and to determine whether it could be risked on the living being, not having any statistics nor the support of any one except Neudörfer himself. I practised both forms of amputations,—viz., where a single bone and also where two bones

were to be divided. The former I performed on the thigh and upper arm, the latter on the forearm. I followed the technique closely in the various steps of the operation. In the thigh I made the incision on the lateral aspect, selecting the junction of the middle with the lower third as the point where the bone was to be divided. In the upper arm I selected the junction of the middle with the lower third. The point of amputation selected in the forearm was the junction of the middle with the upper third.

In these operations I used blocks of wood as a support for the limb during the performance of the osteotomy instead of a sand-bag. I hardly think it necessary to repeat step by step the technique of the various experiments, leaving this to be done in

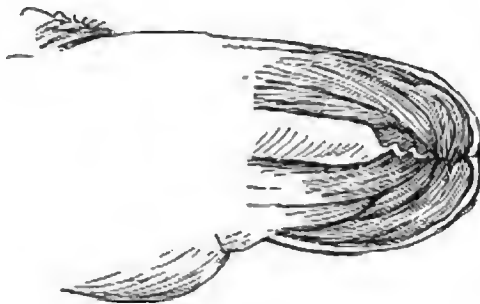


FIG. 5.—Perpendicular section of stump after periosteum, muscles, and skin have been united by continuous catgut suture.

the report on the cases amputated on the living being. I performed a linear osteotomy on the thigh and the same on the humerus. In the forearm I modified this by a partial cuneiform osteotomy. I found that, as far as the resulting stump was concerned, it came up to all expectations,—*i.e.*, a solid, firm, well-cushioned one.

There are two points, however, which also became evident. (1) That some experience is necessary in the performance of the osteotomy,—*i.e.*, so as not to split off or splinter the bone. (2) That some care also is necessary in peeling off the peritoneum, especially at the point where there are strong muscular attachments to the bone; as in the femur in the line of attachments of the adductors, etc.

As "the proof of the pudding is in the eating of it," so also could the other claims of the method be demonstrated only by actual operations on the living being; and it remained for the opportunity to execute them to present itself. The result of my experiments on the cadaver confirmed my original belief, that the method would give a satisfactory result.

In this day of advanced surgery, there is a tendency to overlook many of the other surgical procedures in the *furor* to invade the cavities of the body. Surgeons from the earliest day of surgery have attached a very high degree of importance to amputations; and that the subject was worthy of it is established from the fact of the multitude of methods and forms of amputations that have been handed down to us; and from the illustrious names that are attached to some of them. Volumes have been written on this subject, and the goal, for which all operators and writers have been striving, is the formation of a good stump. It is impossible here to enter fully into the discussion of what constitutes a good stump. The good stump should be of regular outline, firm, solid, insensitive; skin should be mobile; scar should be normal, regular, clean, and lie in a groove in the integument. The bone should be rounded at the end. On this subject, however, I can with propriety quote Treves, in his classical work on "Operative Surgery." "The success of any amputation or method is to be measured, not by the rapidity or brilliancy with which the operation is performed, but rather by the mortality attending the procedure and the quality of the resulting stump. The importance of a sound stump, both as far as it relates to the comfort of the patient and the utility of the mutilated limb, cannot be over-estimated." If we are candid with ourselves, we must admit that it at times takes a great deal of skill and judgment to obtain results that are ideal as far as the qualities of the resulting stump are concerned. We must also admit that many of the poor results after amputations are often due to the carelessness, to the lack of judgment or inexperience on the part of the surgeon. Bungling surgery in the cavities of the body will be covered up, if the patient recovers. Not so in amputations. The "poor job," as expressed in common terms, it always stands as a monument of the skill of the operator.

CASE I.—J. H., aged fifty, married. During late war, in 1861, received a gunshot wound of the right knee-joint. Patient suffered for months on account of the extensive suppuration, which finally resulted in ankylosis. On account of the suppurative process in the leg and thigh, the function of the circulation became so impaired that for the last twenty years the patient has suffered with an extensive eczema of the foot and leg, reaching to the knee. During the last five or six years the foot has been œdematous, and the circulation so impaired that gangrene of one or two toes took place, as well as the formation of plantar abscesses. The toes were removed. The abscesses would not heal. The continual drain on the system undermined the health of the patient, and interfered with his avocation. Five or six years ago, I advised amputation of the limb, but he refused. During the summer and fall of 1893 his health became poor; suffering continually from fever. He now decided to have the leg amputated. His fever having been relieved, as well as an attack of bronchitis, he entered the Rebekah Hospital, December 12, 1893.

Examination of the urine revealed that it was loaded with albumen; no casts. He was prepared for operation for the following day, at 11 A.M. On account of the albumen present in the urine, I felt that possibly some risk might be incurred in the administration of the anæsthetic. In order to reduce the amount of anæsthetic necessary, I ordered one-quarter grain of morphine hypodermically to be given with two ounces of whiskey by the mouth, one hour before the operation, and a similar dose of whiskey one half hour later.

Operation.—Anæsthetic used, chloroform. On account of the previous administration of the morphine and whiskey, the patient came very easily under the influence of the chloroform, and it required very little to keep up the narcosis. Leg rendered bloodless by the Esmarch bandage and constrictor. A sand-bag, 12 by 18 inches, filled with sterilized sand, was used to place under the leg as a support and counter-support during the procedure of chiselling the bone. With a strong resection knife, I made an incision on the outer aspect of the thigh: beginning at the junction of the lower with the middle third, and extending downward a distance of twelve centimetres,—four and one-half inches. The cut was made through the soft parts and periosteum down to the bone. The soft parts being held apart with retractors, the periosteum was peeled away from the bone through the incision in its long axis. I used a curved periosteal elevator, so as to loosen the periosteum on all sides of the bone as much

as possible. Along with the soft parts, it was also retracted away from the bone. The bone was divided by a linear osteotomy at the upper angle of the wound. Division of the soft parts was now done at the lower angle. The division was made with a medium-sized amputating knife, cutting by the circular method at right angle to the axis of the limb, through all the soft parts down to the bone. The lower fragment was now pulled out of its periosteal covering. Vessels were next tied, and the constriction loosened. After the slight parenchymatous oozing had stopped, the wound was sutured. The periosteum was united both longitudinally and transversely, by means of a continuous, buried, fine catgut suture. The various layers of the muscles were also united by a stronger continuous, buried, catgut suture; and, finally, the skin in the same manner. As there were no cavities left in the stump, drainage was not necessary.

The patient made a very favorable recovery. Not any reaction, except on the third day, when the temperature went up to 101.4° F.; but, by opening the bowels freely with a saline purgative, it came down to normal and remained so. Union of wound by first intention. Patient left the hospital on January 9, 1894.

Remarks.—The choice of the site of an amputation is of importance as far as it relates to the limb left. The tendency, at present, is to amputate through sites that will give the best results as to the wearing of an artificial limb; and not to look so much to the conservation of parts. I believe that many of the classical amputations, such as Chopart's, Symes's, etc., will give way to amputations higher up through the continuity of the leg, because an artificial limb can then be adjusted. A good artificial member is better than a poor natural limb. In this case, the ankylosis and the condition of the skin necessitated the choice of site above the knee. Hence, I determined on an amputation at the junction of the lower with the middle third, and by Neudörfer's method. As already stated, I had found, in my experimental studies on the cadaver, that the two points that were a little difficult were the osteotomy and the elevation of the periosteum. On account of the ankylosed condition of the knee, I found it difficult to firmly embed the leg on the sand-bag, so as to form an even resistance to the mallet blows. On this account there was slight splitting of the bone; the spiculæ remaining on the

amputated fragment. In peeling off the periosteum at the site of the insertion of the adductors I found it necessary to use a long blunt-pointed tenotome, in order to facilitate the removal. The slight splitting off of the bone during the osteotomy was productive of no harm, as the osteogenetic properties of the periosteum asserted themselves and formed a perfect rounded end to the bone. This can be demonstrated satisfactorily in the patient's stump. The patient's health has much improved since the operation, and he is now using an artificial leg.

CASE II.—*Amputation for Gangrene Subsequent to an Attack of Grippe*.—J. H., female, age sixty-three, married. Eleven years ago had partial paralysis of right leg. Recovered use of limb after nine months' treatment. Has had good health until November 23, 1893. At this date was attacked by the grippe. During the second week of this attack she complained of coldness and pain in the right foot. In spite of treatment applied to the parts, such as warmth by means of wrapping in cotton and warm irons, this coldness continued. The skin began to become discolored, mottled, and within a few days the evidences of gangrene were present. On consultation it was deemed best to postpone operative interference until her general condition should improve. Under free stimulation, this took place so that on December 18, 1893, she was removed to the Rebekah Hospital. At the time of her admittance into the hospital she was free from fever and the catarrhal symptoms, incident to the grippe, had disappeared.

The line of demarcation of the gangrene was fully established at the junction of the middle with the upper third of the leg. The tissues in the gangrenous portion were beginning to break down. This, then, was the opportune time for amputation; before her powers were again depreciated by the discharges from the breaking down gangrenous tissues.

Operation, 11 A.M., December 19, 1893.—Chloroform anæsthesia, morphia, one-fourth grain, hypodermically; whiskey by the mouth before operation. Amputation of the thigh at the junction of the lower with the middle third; Neudörfer's method. Technique the same as in Case I, with the exception that in this case the incision was made on the anterior aspect of the leg instead of on the lateral, as in the previous case. On day of operation, the evening temperature rose to 101.6° F. Temperature, December 20, the day following

the operation, 99.6°–100.6° F. Gave saline purge and followed this with quinine and phenacetin. Temperature came down to normal and remained there. December 20, saturated dressings were removed. December 21, again dressed and several stitches removed, as there seemed to be some tension in the central part of wound. Union occurred by first intention with the exception of the central part of the wound, where, for about an inch and a half, there was separation of the skin and where union by second intention took place. She left the hospital January 4. Temperature normal and stump in good condition. At home the stump healed completely.

She was sitting up and beginning to walk around on crutches, when one day she drank some buttermilk, brought her by a neighbor. An attack of gastro-enteritis followed, from which she never recovered. She lingered along until April 11, when she died, as I take it, from auto-infection produced by the buttermilk.

Post-mortem allowed. Patient much emaciated and decubital ulcer over nates. Stump healed; a slight red spot that had been present on the extremity over site of bone while living was now gone. Scar somewhat broad in centre, situated posteriorly and movable. End of stump finely rounded and firm. Bone rounded at the end, stump removed. No examination of the organs allowed.

Remarks.—In Case II, I selected the site of amputation at the junction of the lower with the middle third of the thigh for the following reasons: In the gangrene of the aged, where the gangrene begins at the toes and the region supplied by the anterior tibial artery is involved, the experience of German surgeons has proved that a thrombus is likely to extend in the artery to the bifurcation of the popliteal, and sometimes beyond. An amputation below this point, although at the point of election or higher, is often followed by secondary gangrene, and a higher amputation becomes necessary. I have seen examples of this occur in the practice of such men as Hahn and Kuester, in Berlin, so that with them it has become a rule to amputate high up above the bifurcation of the popliteal. As I did not want to take any chances, I did the operation at the site stated.

Neudörfer, at the time of the publication of his paper, had done the operation three times. The first was a thigh operation; the second was also a thigh operation; the third was an amputation of the leg.

The two operations reported in this paper are the only ones, so far as I know, that have been done in this country according to this method. Based on my experiments on the cadaver and the experience gained on the living subject, in the cases above reported, I beg to submit for further consideration the following

CONCLUSIONS.

(1) That the method of Neudörfer is one that offers, from a theoretical stand-point, all the conditions favorable for the formation of a good stump.

(2) That inasmuch as no anatomical relations of muscular planes and tissues contained between them are disturbed, there is the least risk to the vitality of the parts, and the most favorable condition for union by first intention.

(3) Such being the case, the muscles cannot retract, and hence must form a solid firm stump.

(4) That it offers most favorable conditions for a good cicatrix.

(5) That the preservation of the periosteum insures its osteogenetic properties, and therefore the more favorable conditions are preserved for a good contour to the end of the bone.

(6) That in the chiselling of the bone and peeling off of the periosteum no serious obstacles are encountered.

(7) That the chisel is not likely to produce as much injury to the bone as the saw, and therefore not as likely to be followed by a necrosis of the end of the bone.

(8) That, in the main, Neudörfer's conclusions, as far as my experience goes, can be verified.

(9) That it will take further experience, however, on the living subject to place this method on a proper basis as a surgical procedure.